

# Analysis of methods for generating electricity from secondary energy resources

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**Abstract.** This article explores several ways to extract electrical energy from ionization processes that are produced in different homogeneous concentrated environments as a secondary energy resource. The principles of operation of existing methods as well as the applications of these methods have been researched. Bipolar membrane reverse electrodialysis method, reverse electrodialysis method, is an electrical potential generation formula of pressure-slowed osmosis methods used in obtaining electrical energy. as well as the principle of operation is analyzed. This study aims to identify and compare the existing methods and methodologies of energy harvesting, and is an effective technology for the application of these methods in large volumes of fresh and salty liquids. The proposed technology involves the experimental electrolysis processes and the determination of the output of different results at different concentrations of solutions.

## INTRODUCTION

As a result of the analysis of electricity consumption in today's mining enterprises, the need for electrical energy is increasing. As well as the fact that Comm enterprises are located far from the electric power plant, it is necessary to study other methods of production of electricity, namely the use of secondary energy resources (IERS), as well as to conduct scientific research. Currently, 3 large groups can be cited as secondary energy resources that we can see in Figure 1 below.[1-9]

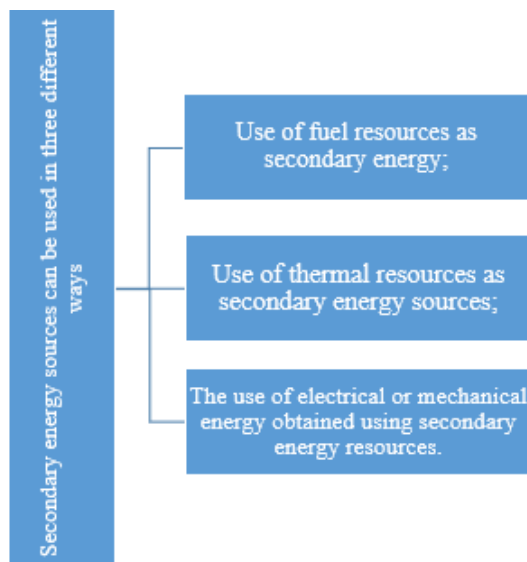


FIGURE 1. Schematic diagram of the directions of using their IERS

It can be seen from this that the fuel energy is the re-use of heat from the smoke and ash of the burned fuel. as well as heat resources as heat-permeable materials, taking heat in a state that has used the properties of heat and reuse [10-15]. The possibility of using electricity and mechanical energy in the case of using IER resources, that is, the methods of obtaining and using electricity using electrolysis processes from liquids, alkalis, acids, brine of various concentrations used are widely used in the world and research is being carried out [16-20]. Such methods are common in the world:

- 1.bipolar membrane reverse electrodialysis method;
- 2.reverse electrodialysis method;
- 3.The possibility of using electric

## EXPERIMENTAL RESEARCH

These methods are considered to be significant in obtaining electricity in low-concentration acidic mixtures, both in alkaline and in waters with low salinity.

The bipolar membrane reverse electrodialysis method is an electrochemical technology that generates an electrical voltage using the energy of the uneven distribution of ions between two solutions with different salt concentrations (e.g. salt and fresh water). Can be used primarily to generate electricity using neutralization, representing an effective way to reuse waste. The bipolar membrane consists of two layers:

- Cation exchanger layer-transfers only positively charged ions ( $\text{Na}^+$ ,  $\text{K}^+$ );
- Anion exchanger layer- only transfers negative ions ( $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ );



As a result, the total ion flow through the membrane increases, the electro-chemical potential of the system increases. Under the influence of an electric field, the degree of ionization increases sharply and increases the potential field. This method involves several processes in which electrical energy coagulation depends on the concentration gradient between salt and fresh water's a result, the total ion flow through the membrane increases, the electro-chemical potential of the system increases. Under the influence of an electric field, the degree of ionization increases sharply and increases the potential field [27-56]. This method involves several processes in which electrical energy coagulation depends on the concentration gradient between salt and fresh water. The waters pass through alternately located chambers, which are successively crossed by the anionic alternating layer – the cationic alternating layer –the bipolar membrane layers, and separated by their membranes. Concentration abundance and gradient force ions into the mortar and natural diffusion occurs due to the abundance of ions in the saline solution and the scarcity of ions in the fresh water. This diffusion is regulated by the layers in the membranes. For example, the anion layer of the membrane transports ions such as  $\text{Cl}^-$ . The exchange layer is  $\text{Na}^+$ . The main bipolar membranes produce additional ions by splitting water into  $\text{H}^+$  and  $\text{H}^-$ .

The reverse process analysis method is a membrane electrochemical process in which electricity is produced using the natural diffusion energy of ions between two solutions where the concentration of salts varies dramatically. Salt water ions tend to migrate to fresh water. When the chemical energy hidden in their migration is converted into orderly motion through membranes, an electric current is generated. The physicochemical nature of the reverse electrodialysis method is that the difference in ion concentration based on the Nernst equation produces a potential in the galvanic element [21-26].

The Nernst equation shows the Rel voltage value generated in Oracle electrodes (electrically conducting force as source), and its representation has the following representation:

$$\xi = \frac{R \cdot T}{z \cdot F} \ln \frac{C_{\text{tuzli}}}{C_{\text{chchuk}}} \quad (2)$$

where: R – is the universal Gas Constant ( $R = 8.31 \text{ J}/(\text{mol}/\text{K})$ ), T – is the absolute temperature of the liquid, z – is the number of charges of the ions, F - Faraday constant ( $F = 96485 \text{ C}/\text{mol}$ ),  $\frac{C_{\text{saline}}}{C_{\text{rat}}}$  –is the ratio of concentrations of salt water and fresh water.

## RESEARCH RESULTS

This method is similar to the bipolar membrane method but does not have a bipolar membranal in the middle. The principle of operation is the same. These methods are compared to the main parameters in Table 1 below.

**TABLE 1.** Comparison table of bipolar membrane method and reverse electrodialysis methods

Indications	Reverse electrodialysis method	Bipolar membrane electrodialysis method
Voltage	Medial	2-3 times higher
PH stability	Weak	Strong
Water decomposition	No	Boron (H <sup>+</sup> and OH <sup>-</sup> are formed)
Energy efficiency	Medial	High
Acid/base formation	No	Available

The pressure-slowed osmosis method is a technology that draws energy from the osmotic pressure difference between two solutions of different concentrations. It is also called "blue energy", meaning that it is one of the sources of electricity and can be used where sea and river water mix. It is used by separation through a semi-permeable membrane. According to the law of the nature of osmosis: fresh water moves towards the saline solution. During this transition period, osmotic flow occurs. If pressure is applied to the Salt side, the speed of water movement slows down — so the technology is called "pressure slowing". A special semi-permeable membrane is used in this process. Its function: to transfer only water molecules, not salt ions (na<sup>+</sup>, Cl<sup>-</sup>). As fresh water passes through the membrane, the volume of fluid on the Salt side increases, which increases the internal pressure. The energy of this watercourse is converted into hydraulic energy and electricity is generated from turbines' pressure is applied to the Salt side, the speed of water movement slows dol pressure.

$$\pi - P \quad (3)$$

where  $\pi$  is the osmotic pressure,  $P$  is the external pressure.

If  $\pi < P$  continues the flow of water and an Energia is obtained. In this method, fresh water moves through the membrane towards the salt water. Then, as the volume increases on the salt water side, the hydraulic pressure force becomes hazel. The generation of electrical energy is in the following sequence. Current energy → mechanical energy → electrical generator → electrical energy. Also on the osmotic energy → hydraulic pressure → electrical energy chain  $\pi < P$  continues the flow of water and an Energia is obtained. A.

$$\pi = iMRT \quad (4)$$

where  $i$  is the Vant Hoff coefficient,  $M$  is the molar concentration of the solution. There is also a lot of electricity if the osmotic pressure is large.

## CONCLUSIONS

From the above, the initial data was presented in the form of a table (in Table 2) and the main parameters of each method were compared.

**TABLE 2.** Comparison table of methods for obtaining electricity from IER

Parameters	Pressure-retarded osmosis method	Reverse electrodialysis method	Bipolar membrane reverse electrodialysis method
The main source of energy	Osmotic pressure difference → hydraulic pressure	Salt concentration difference → ion migration	Salt difference + energy of water dissociation through a bipolar membrane
Membrane type	Semi-permeable, only water passes through	AEM va CEM ion selective membrane alar	AEM + CEM + BPM (bipolyare Membran)
Ionenlernen roli	Salzionen passieren die Membran nicht, nur Wasser passiert sie	Ionen passieren ordentlich	H <sup>+</sup> - und OH <sup>-</sup> Additivausbeuten
Art der erzeugten Energie	Hydraulikdruck → Turbine → elektrische Energie	Elektrochemisches Potential → direkte elektrische Energie	Erhöhtes elektrochemisches Potential → Hochspannung
Steuerelemente	Pump, Hydraulic block	Electrode, Membrane module	Electrodes + bipolar membrane elements
Analogon des natürlichen Prozesses	Osmosis	Ion diffusion	Ion dissosiasiyasi + diffuziya

Thus, using the methods described above, the bipolar membrane reverse electrodialysis method, based on the methods used to obtain electric Energia from the IERS, is a more efficient method.

In this case, the extraction of electricity from alkaline low-concentration acidic saline mixites showed important ways in the production of electricity in mining enterprises.

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